Clinical Update

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Endodontic nickel-titanium rotary instruments

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Introduction

The purpose of this clinical update is to familiarize clinicians with three popular endodontic rotary instrument systems that are now available.

Background

Automated root canal preparation has existed since the end of the nineteenth century. It was introduced to decrease instrumentation time and simplify root canal preparation. Due to problems of increased canal blockage, instrument breakage, and insufficient canal debridement, it never gained popularity. These problems were not the result of the engine driven systems but were caused by the use of stainless-steel files. With the introduction of nickel-titanium (NiTi) files, the popularity of rotary systems and instruments increased. Walia et al. have shown that NiTi files have two to three times more elastic flexibility in bending and torsion as well as superior resistance to torsional fracture when compared with size #15 stainless-steel files (1). These physical attributes are natural advantages which may lead to enhanced negotiation in curved canals, decreased canal transportation and ledging, and decreased operator fatigue. Many of these features which are mentioned in advertising and marketing have yet to be validated by scientific studies.

NiTi rotary instrumentation should always be performed with slow-speed, low-torque electric motors. If a high torque motor is used, the instrument-specific torque-limit (fracture resistance) is usually exceeded resulting in instrument separation (2).

Currently, there are several types of NiTi systems available: Profile (Dentsply, Tulsa Dental), Quantec (Analytic Technologies), Lightspeed (Lightspeed Technologies), Endomagic (Tycom), Pow-R (Moyco, Union Broach), Naviflex (Brasseler), and 642 HERO (Micro Mega). Each system has its unique design and advantages and no one system is truly better. The most common feature in the majority of the rotary files, is the radial land, which is illustrated by brackets in Figure 1. By adding mass peripherally, the radial land prevents uncontrolled cutting into the canal walls. This minimizes transportation and contributes to the strength of the instrument. This update focuses on the three most popular brands: Profile, Quantec, and Lightspeed.

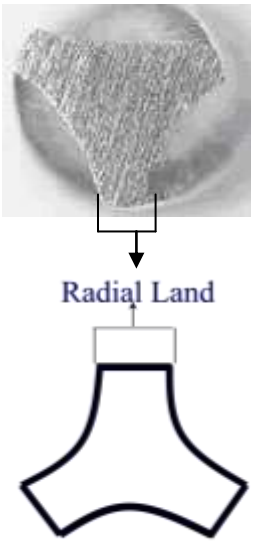

Figure 1
Photo Copyright 1998
Dentsply Tulsa Dental

Profile (Dentsply, Tulsa Dental)

The Profile instruments have a bullet nose, which is a non-cutting tip, and has a U-shaped design and flat outer edges. The files cut with a planning, rather than a scraping action, resulting in a more centered canal. The rotary Profile series are available in five different types: Greater Taper series (GT), .04 taper series, .02 taper series, Series 29, and Orifice Shapers. The manufacturer's suggested technique is a crown-down sequence starting with Orifice Shapers for coronal flaring, followed by .04 or .02 series in tip sizes 20, 25, 30 and 35 for apical shaping, and completing instrumentation with a GT for the desired canal taper.

Quantec (Analytic Technologies)

Quantec instruments have several unique design features. First, the peripheral strengthening feature inherent in the radial land has been accentuated. The lands are wider than those of the Profile and a double radial land has been incorporated to reduce friction. Secondly, the Quantec files have a slightly positive cutting angle which allows the flutes to cut rather than scrape the dentin unlike the Profiles which plane. Thirdly, the helical angle increases from 30° at the tip, to 45° near the shank. This assists in rapidly channeling debris out of the canal. Lastly, the combination of the new Axxess Contra Angle handpiece attachment and Axxess handles (shanks) on the files provides an overall height reduction of over 7 mm. This improves access to posterior teeth. The Quantec series is available in the Axxess series of 10 files which have both safe cutting (SC) and non-cutting (LX) tips and includes three flare series files. The manufacturer's suggested technique is a modified crown-down sequence that begins by establishing a glide path with hand instruments to working length, then is followed with a larger tapered rotary file at the orifice, and progresses with files of lesser taper, until working length is achieved.

Lightspeed (Lightspeed Technology)

Lightspeed was originally developed by Senia and Wildey as the Canal Master series. Canal Master files resembled Gates Glidden drills with a long shaft and a short cutting tip. Lightspeed is a NiTi version of the Canal Master instruments and the files have a non-cutting pilot with a cutting segment of 1-2 mm. According to the manufacturer, the very short cutting

blades allow a safe apical preparation and the taperless shaft gives the file more flexibility than any of the other rotaries. Therefore, the file stays more centered, and zipping and transportation are eliminated. Risk of instrument separation is very low, and the file is designed to separate 18 mm from the tip for easy retrieval, if separation does occur. The manufacturer's suggested technique recommends coronal preflaring, working length determination and instrumentation with a step-back technique. The instruments are available in ISO sizes 20-100, with ½ sizes between 20 and 65.

Advantages and Disadvantages

The idea of faster canal preparation and increased flexibility of rotary NiTi instruments has intrigued dentists and has created the notion that instrumentation skills are less important since the NiTi rotary files are more forgiving and user friendly. However, NiTi files are not without problems. When stressed, the metal undergoes a crystalline phase transformation and can become structurally weaker and/or fatigued without any visible or macroscopic signs, resulting in breakage without warning (3,4). One should track the number of uses of each file to minimize the incidence of instrument separation. File life span varies depending on how many times the file is used, use in single versus multiple canalled teeth, how the instrument is stressed and torqued during each use, degree of canal curvature, and the manufacturer's instructions.

Studies by Bryant et al. have shown that rotary preparation with the Profile .04 series is not only quicker than hand instrumentation, but also removed more dentin from the outer aspect of the canal curve, resulting in zips and transportation (5,6). Studies by Thompson and Dummer reported that Quantec files prepared smooth canal walls with great taper, but the larger size files tended to produce zips and ledges in curved canals and should not be used at full working length (7,8). In other similar studies by Thompson and Dummer, it was reported that the Lightspeed rotaries prepared the canals rapidly but showed poor taper characteristics (9,10). One of the main advantages of two of the rotary systems has been the recommended crown-down preparation technique, because this technique has been shown to pull pulpal remnants, bacteria, and debris out of the canal rather than pushing them into the periradicular tissues (11).

The cost of an electric motor and endodontic reducer contra angle (18:1 gear reduction) is approximately $900. The cost of the NiTi files is also a consideration. The current government prices are: Quantec - $37.90 / set of ten, Profile - $22.11 / package of 6, and Lightspeed - $200 / set.

When and how should you use rotary files?

There is a significant learning curve with NiTi rotary instrumentation. The clinician needs to have a clear understanding of the proper use of the chosen system. Also, the prudent practitioner should practice on resin blocks and then extracted teeth, prior to using a system clinically.

Careful case selection is the key to effective and successful rotary instrumentation. Teeth with severely curved or S-shape roots should not be instrumented by rotary files to the working length because a NiTi file in a curved canal will have the tendency to straighten itself, resulting in transportation, zipping, and stripping. Haiekel et al. have shown that the radius of curvature is the most significant factor in terms of predicting cyclic fatigue failure (separation) of the instrument.(12) In other words, the more curved the canal, the greater the risk for separation.

Clinicians should pay close attention to the manufactures' recommended technique and RPM settings. A recent study has shown that rotary files used at higher RPM (333.33) are four times more likely to separate and distort than at a lower RPM (166.67) (13). As a general precaution, all rotary files should be carefully inspected for any sign of distortion or unwinding both before, and after, they are used in any canal.

Conclusion

Both the start-up cost for a rotary system, and the overhead for the systems are high, due to the cost of the files. The benefits of the technique and the potential for increased efficiency, make rotary systems an important part of modern endodontic practice.

As more research is performed comparing hand instrumentation to rotary instrumentation, it becomes increasingly evident that each rotary system has its own unique advantages and disadvantages. No system is clearly superior. Therefore, we are likely to see recommendations for techniques that include a combination of hand files, as well as a combination of rotary systems. Refer to Table 1 for the summary of rotary files.

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Note: Any brand names used in the *Update* are for illustrative purposes only. It does not imply recommendations or endorsement by the Department of the Navy

Table 1: SUMMARY OF ROTARY INSTRUMENTS

	Complete set	Technique	Tip	Adjuncts	Recommended RPM
Quantec (Tycom) Flare series	10 Instruments 3 Instruments	Establish a "Glide path" with hand instruments up to size #25 followed with Flare series and Quantec series in crown down approach **(Modified Crown-Down Technique)**	SC safe cutting LX non-cutting	Light pecking motion	300 to 350
Endomagic (Tycom)	10 Instruments numbered from 1 to 10	Start with file#1 orifice opener followed with files #2-#10 in **(Crown-Down Approach)** Use #15 sonic file after each step	Non-cutting	Recommend using KY jelly	300 to 350
Lightspeed (Lightspeed Tech.)	22 Instruments sizes 20-100 ½ sizes 20-65	- Coronal Preflaring - Start with the first Lightspeed file to bind before working length **(Step-Back Technique)**	Non-cutting	Use with **EDTA**	750 to 2000
Profile (Dentsply) GT Series	4 Instruments	**(Crown-Down Approach)** using .04 series at apical	Non-cutting		150 to300
.04 Series	5 Instruments	**(Crown-Down Approach)**	Non-cutting		300
Orafice shapers	6 Instruments	**(Crown-Down Approach)**	Non-cutting		300 to 350
POW-R (Moyco) .04 Series & **Coronal shapers**	9 Instruments	Can be used with either **(Step-Back)** or **(Crown-Down)**	Non-cutting "R" bullet tip		150 to 300
RBS (Moyco)	4 Instruments	**(Crown-Down Approach)**	Non-cutting		150 to 300